REMOTE MONITORING OF DOORDARSHAN TRANSMITTERS

by

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Certificate

It is certified that the work contained in the thesis entitled **REMOTE MONITORING OF DOORDARSHAN TRANSMITTERS**, by Sumeet Goyal has been carried out under our supervision and that this work has not been submitted elsewhere for a degree.

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Abstract

In any Broadcasting institution strict quality control over the transmission is of utmost importance. For that a regular, and a widespread monitoring network is necessary. The aim of this work was to make a prototype environment for monitoring the transmitters in the Doordarshan Broadcasting setup from a remote location, so that an efficient check can be maintained on the quality of transmission. A model setup for remote monitoring has been made and tested. The software has also been written to give a feedback to the transmitter containing necessary instructions to improve the quality of transmission and rectify the faults which are indicated by the measurement values. The past values of different measurement parameters have been plotted to allow an easy check over the parameter's status

Measurements were modelled on the universal television signal analyser 2924, which, is widely used in Doordarshan. Various capabilities of this instrument were studied and their uses were suggested to make a wholesome monitoring environment.

Dedicated To

My Parents and Wife

Acknowledgements

I express my deepest gratitude to my supervisors Dr. P K Chaterjee and Dr. Joseph John for providing me valuable suggestions and encouragement during my DIIT project work at I. I. T. Kanpur. I really appreciate them for their kind nature, to discuss the technical matter at any odd hours. Without their help, this work would never have been completed.

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June 1996 **Sumeet Goyal**

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Chapter 1

Introduction

The main categorisation of the transmitters is on the basis of its power i.e., High power transmitter (HPT), Low power transmitter(LPT), and Very low power transmitter(VLPT). HPT's power is about 10 KW, LPT's power is in the range of 100 W to 1KW and VLPT's power is in the range of 5 to 25 W. In the Doordarshan setup of India, transmitter is situated away from the site of studios, generally 3 to 4 Kms. That is where the need for remote monitoring arises. At present monitoring is done by the staff operating the transmitter. Which is not adequate, as proper checks can not be maintained as the same persons are required to do both monitoring as well as operation of the transmitter.

Another area which involves remote working is Outside Broadcasting(OB's). In OB's a small studio is required to be setup at various locations, away from the Doordarshan Kendra, depending on the location of the event being covered. Then the signal is sent to the parent Doordarshan Kendra via short haul microwave links and telephone lines(wideband) for the areial transmission. In this case also a proper monitoring setup is lacking.

1.1 A Doordarshan Kendra Setup

Nowadays 99 percent of the transmission through the studios is not 'LIVE'. So the source of studio signals transmissions are, generally Video tape recorders (VTR). The transmission signals (video+audio) from the VTR are routed to the Central Appara-

tus Room (CAR), where most of the electronics hardware of the equipments is kept. Basically CAR is a central monitoring room as all the criss-crossing signals are routed through CAR only.

From the CAR the signal goes to the transmission studio, where the required video signal is cut (switched) to the output (Programme output). Transmission studio output goes to the Master Switching Room (MSR), where the video signal is passed through a stabilizing amplifier (STAB) to correct the signal for minor discrepancies like peak to peak amplitude distortion, color saturation, setup level, burst level etc. The block diagram of doordarshan setup is given in fig. 1.1

From the MSR the signal is fed to a microwave link (short haul link) connecting the

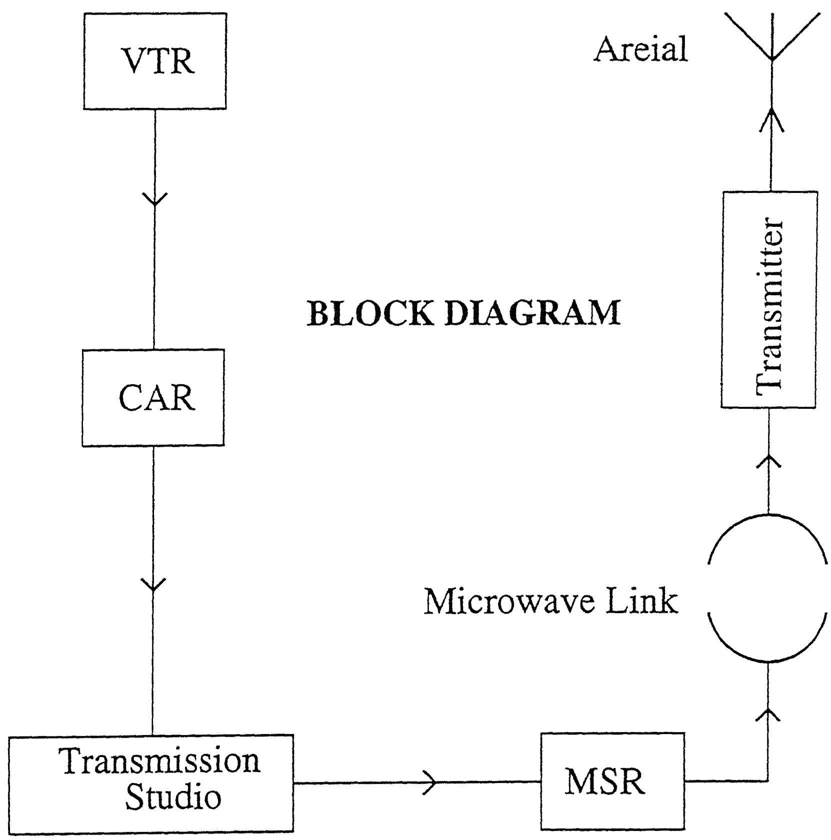

Figure 1.1: Doordarshan Setup

studio and the transmitter. At the transmitter end, the received baseband signal is fed via hum suppressor and STAB to the transmitter.

1.2 Importance of Video Measurements and Monitoring

Subjective assessments of picture quality[1] fulfil an important role in the development of new television standards and in making operational performance judgements. Though a viewer's perception of the quality of the pictures or sound presented to him by a television system is the ultimate test of its performance.But, we have to have objective video measurements to quantify the video impairments that is a natural extension to the use of subjective performance statements. It is quite useful to be able to relate the subjective assessment of the picture quality to the objective measurement of an impairment. Both manual and automatic objective video performance measurements play important role in the development and installation /operation and maintenance of studio equipments, distribution networks and transmission systems.

So video measurements provide us with a basic tool to keep a check on video performance quality, which is of utmost importance in a Broadcast environment. For Broadcast quality picture, stringent video measurement requirements, as specified by CCIR/CCITT, are to be continuously met, i.e., a proper monitoring is required to produce high quality picture. Besides helping us in providing Broadcast quality transmission, a not so direct result of monitoring is in reducing the hours of Breakdown. Through regular monitoring even a slight deterioration in video performance can be detected thereby indicating to us some faulty condition (howsoever small it maybe), well before it results in a breakdown.

In short monitoring is very useful or we should say must for providing Broadcast quality transmission.

1.3 Need For Remote Monitoring

As explained earlier in this chapter, transmitters are located at a site away from the studios. So as to keep a proper check, remote monitoring (of demodulated video of transmitter) facility is required at the studios. Basically, what is required to be done is to demodulate the coupled output (attenuated) of the transmitter through standard

demodulators. Then the video- parameters of the demodulated video are required to be measured.

Secondly, at big kendras, like Delhi, there maybe more than one transmitters. So in such cases, also a centralized monitoring base is required to have proper quality control.

1.4 Scope of Work

In this thesis a laboratory setup for remote monitoring, representing the remote and local ends by two PC's and the channel by a simple 7-pin cable(between the two serial ports), was made and studied. Also a general structure for processing(i.e., corrective measures/instructions based on the received measurement data , to be fed back to the local end i.e., transmitter/OB location) was shown. The processing will have to be modified according to the type and make of the transmitter in use and also according to the area of use as in case of OB's.

1.5 Organisation Of the Thesis

Chapter 2 has been divided into two parts. In the first part, the significance of important video parameters is given, in particular, stressing the effects of different video impairments on the television picture. In the second part, the important features and capabilities of the video measurement equipment, Universal Television Analyser - 2924, is given.

Chapter 3 describes the setup of the project and also gives a brief discussion on the functions of the programs used in this work. Detailed processing along with the results on some actual readings(i.e., the received measurement data)has also been included in this chapter.

Chapter 4 concludes the thesis giving suggestions for future work.

Appendix A gives an idea about the software, C-Asynch Manager, which has been used in the programs.

Appendix B gives information about the RS-232 interface.

Chapter 2

Video Measurements and Impairments

In the first part of this chapter a general idea about the important video parameters[2] is given. A brief description of a video measuring instrument (universal television signal analyser 2924, Marconi make used by Doordarshan) is given in the second part of this chapter.

2.1 Important Video Measurement Parameters

To characterize television system performance, a proper understanding of signal distortions and measurement methods is required. While there is agreement about the nature of each distortion, definition for expressing the magnitude of distortion may vary considerably from standard to standard. A misunderstanding about these can seriously affect the measurement results, so it is very important to become familiar with the definition of the video parameters and television measurements.

Television measurements can be broadly categorized in four parts:(block diagram is also shown in Fig. 2.1)

1. **Amplitude and Timing Measurements**
2. **Linear Distortions**
3. **Non-linear Distortions**
4. **Noise Measurements**

These are discussed briefly in the following subsections.

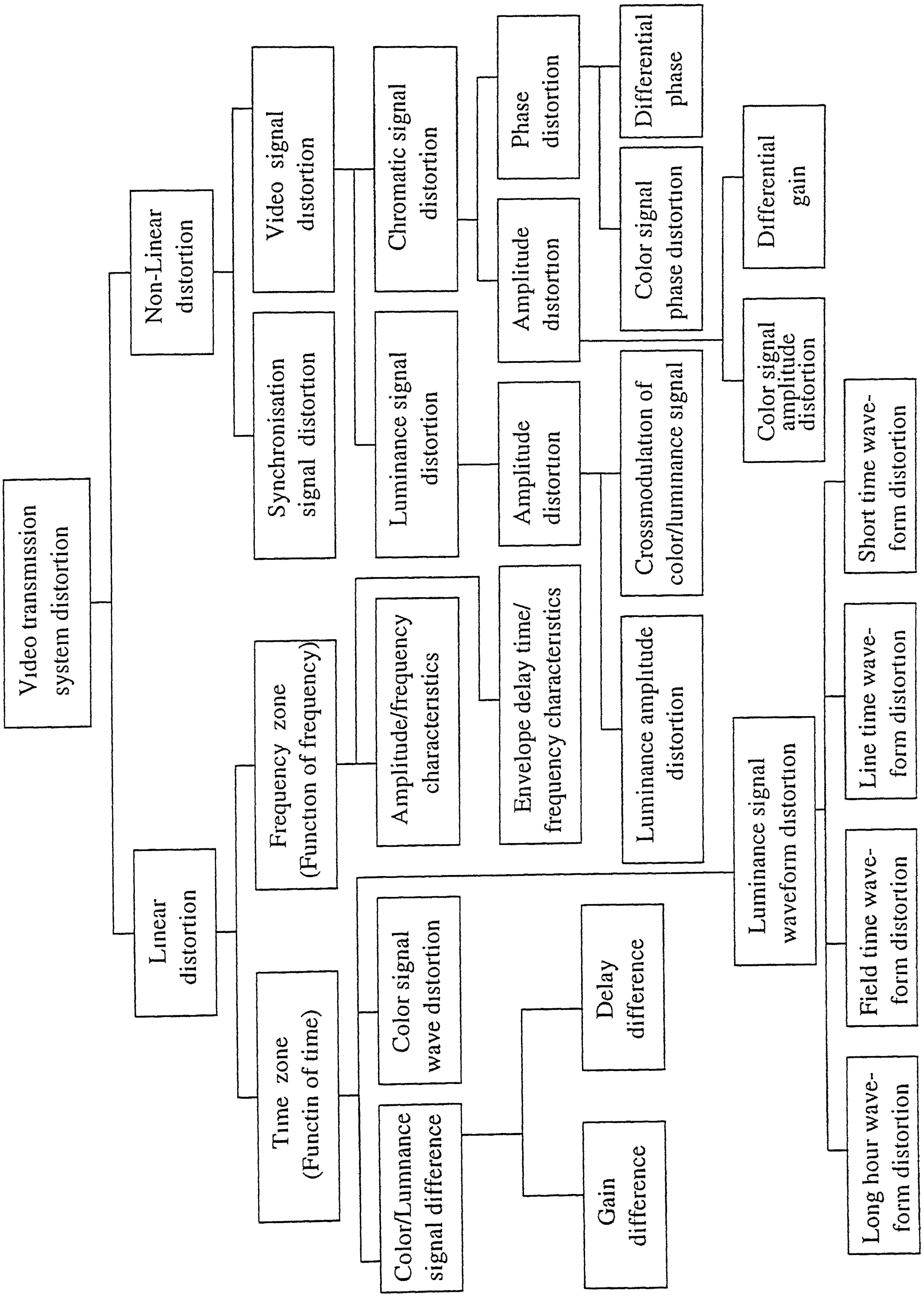

Figure 2.1: Video Transmitting System Distortions(As defined by CCIR)

2.1.1 Video Amplitude Measurements

Two kinds of amplitude measurements are important in television systems. Absolute levels, such as peak to peak amplitude, need to be properly adjusted. The relationship between parts of signals is also important. The ratio of sync to the rest of the signal, for example, must be accurately maintained.

When setting video amplitudes, it is not sufficient to simply adjust the output level of the final piece of equipment in the signal path. Every piece of equipment should be adjusted to appropriately transfer the signal from input to output, since television equipments are not designed to handle signals which deviate much from nominal 1-Volt peak to peak amplitude. signals which are too large can be clipped or distorted, and signals which are too small suffer from degraded signal to noise performance.

PAL composite video signals are nominally 1-Volt peak to peak. If the amplitude doesn't conform to this nominal value then appropriate gain adjustments should be made.

Amplitude errors cause picture to appear too light or too dark. Because of the effects of the ambient light, apparent color saturation is also affected.

Sync and Burst

Sync and Burst should each measure 30% of the composite video amplitude (300 millivolts for a 1-Volt signal). The video signal's amplitude as per CCIR recommendations is given in Fig. 2.2

If Sync amplitude is very less, it can result in unlocking of signal at the receiver end. Due to Burst amplitude variations color saturation can be affected at the receiver end.

2.1.2 Timing Measurements

Though sync pulse widths and rise times are measured less often, still they are important. The video signal's timings as per CCIR recommendations is given in Fig. 2.2 Horizontal and vertical synchronisation pulse widths should fall within the limits

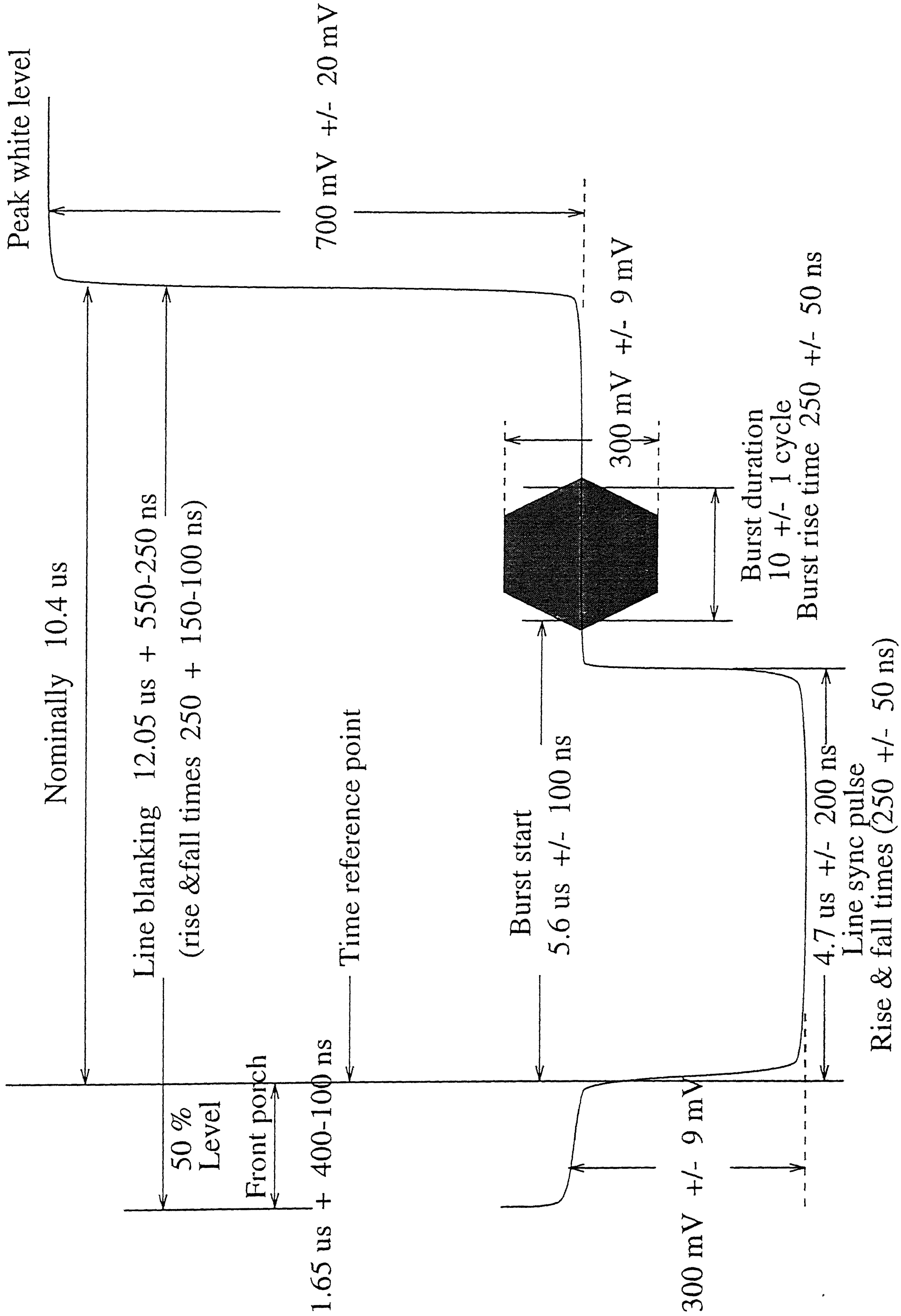

Figure 2.2: The Position and Amplitude within the 625-Line System

specified in a standard or as required by a Broadcasting authority.

Small errors in pulse widths will not effect picture quality. If the errors become so large that the pulses cannot be properly processed by equipment, picture breakup may occur.

2.1.3 Linear Distortions

Waveform distortions which are independent of signal amplitude are referred to as linear distortions. These distortions occur due to systems inability to transfer amplitude and phase characteristics at all frequencies.

When fast signal components such as transitions and high frequency chrominance are affected differently than slower line-rate or field-rate information, linear distortions are most probably present. These distortions are most commonly caused by imperfect transfer characteristics in the equipment in the signal path. However, it can also be externally introduced. Signals such as power line hum can couple into the video signal and manifest themselves as distortions.

Linear distortions can be broadly classified into four categories:

1. **Short Time** (100 nanoseconds to 1 microseconds)
2. **Line Time** (1 microseconds to 64 microseconds)
3. **Field Time** (64 microseconds to 20 milliseconds)
4. **Long Time** (greater than 20 milliseconds)

Besides these, Chrominance to Luminance Gain and Delay measurements are also important. (shown in Fig. 2.3)

Chrominance to Luminance Gain Inequality

Definition

Chrominance to Luminance gain inequality (relative chrominance level) is the difference between the gain of the chrominance components and the gain of the luminance components as they pass through the system. The difference is expressed in percent or dB, and the number is negative for low chrominance and positive for high chrominance.

Gain errors most commonly appear as attenuation or peaking of the chrominance information, which shows up in the picture as incorrect color saturation.

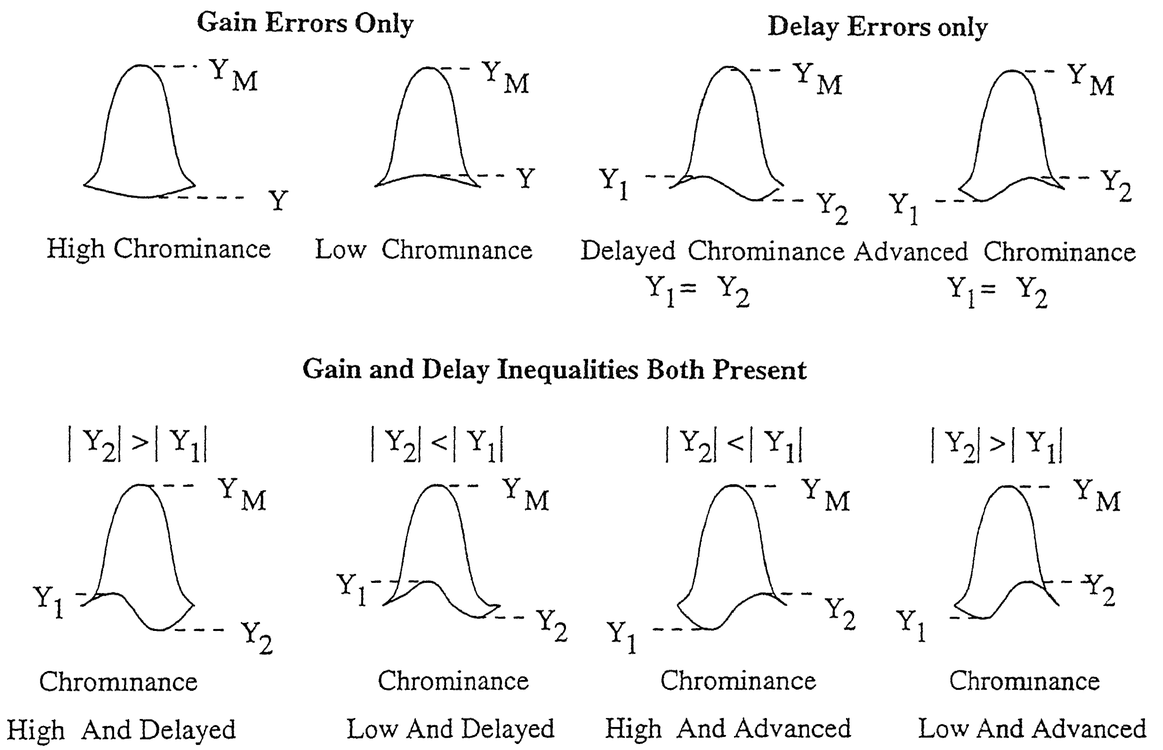

Figure 2.3: Effects of Gain and Delay Inequalities on the Modulated Sine-squared Pulse

Chrominance/ Luminance Delay Inequality

Definition

Chrominance/ luminance delay inequality (relative chrominance time) is the difference between the time it takes for the chrominance portion of the signal to pass through the system and the time it takes for the luminance luminance portion to pass through. The amount of distortion is usually expressed in units of time, typically nanoseconds. The number is positive for delayed chrominance and negative for advanced chrominance.

Delay distortion will cause color smearing or bleeding, particularly at the edges of the objects in the picture. It may also cause poor reproduction of sharp luminance transitions.

Short Time Distortions

Short time distortions cause amplitude changes, ringing, overshoot and undershoot in fast rise times and 2T pulses. The affected signal components range in duration from 100 nanoseconds to 1 microseconds.

Short time distortions produce fuzzy vertical edges. Ringing can some times be interpreted as chrominance information (cross color), causing color artifacts near vertical edges.

Line Time Distortions

Line time distortion causes tilt in line rate signal components such as white bars. The affected signal components range in duration from 1 microseconds to 64 microseconds. The amount of distortion is expressed as a percentage of the amplitude at the centre of the line bar amplitude

In large picture details, this distortion produces brightness variations between the left and right side of the screen. Horizontal streaking and smearing may also be apparent.

Field Time Distortions

Field time distortion causes field rate tilt in video signals The affected signal components range in duration from 64 microseconds to 20 milliseconds. The amount of distortion is generally expressed as a percentage of the amplitude at the centre of the line bar(at field rate).

Field time linear distortion will cause top to bottom brightness inaccuracies in large picture details.

Long Time Distortions

Long time distortions affects slowly varying aspect of the signal. such as Average Peak Level (APL) changes which occur at one second intervals. The distortion usually appears as a very low frequency damped oscillations. The affected signal range in duration from 20 milliseconds to 10s of seconds. The peak overshoot which occurs as a result

of an APL change, is expressed as a percentage of the nominal luminance amplitude, is generally quoted as the amount of distortion. Settling time is also sometimes given and occasionally the slope at the beginning of the phenomenon, in % per second.

Long time distortions are slow enough that they are often perceived as flicker in the picture.

Frequency Response

Frequency response measurements evaluate the system's ability to uniformly transfer signal components of different frequencies without affecting their amplitudes. That is it evaluates the system's amplitude response over the entire video spectrum. The amplitude variation can be expressed in dB or percent. The reference amplitude is (0 dB, 100%) typically the white bar or some low frequency.

Frequency response problems can cause a wide variety of aberrations in the picture, including all the effects enumerated under short time, line time, field time and long time distortions.

2.1.4 Non-Linear Distortions

Amplitude dependent waveform distortions are often referred to as non-linear distortions. This classification includes distortions which are dependent on APL and/or instantaneous signal level changes.

Since amplifiers and other electronic circuits are linear over a limited range, they may tend to compress or distort large signals. The result is non-linear distortion of one type or another. Non-linear distortions may also manifest themselves as cross talk or inter-modulation effects between the luminance and chrominance portions of the signal.

The most frequently measured non-linear distortions are:

1. **Differential Phase Errors**
2. **Differential Gain Errors**
3. **Luminance Non-Linearity**

4. Chrominance Non-Linear Phase
5. Chrominance Non-Linear Gain
6. Chrominance to Luminance Intermodulation

Differential Phase

Differential phase errors are present if a signal's chrominance is affected by luminance level. This phase distortion is the result of system's inability to uniformly process high-frequency chrominance information at all luminance levels. The amount of differential phase distortion is expressed in degrees.

Since virtually all PAL receivers now employ delay line decoders, so a reasonable amount(< 10%) of differential distortion can not be readily detected in the picture. Actually, the phase shift errors should produce hue errors in the picture but due to the use of delay decoders the hue errors get converted to gain errors, which are much less objectionable in the picture.

Differential Gain Errors

Differential gain errors are present if chrominance gain is dependent on luminance level. These errors are a result of system's inability to process high frequency chrominance signal at all luminance levels. Differential gain distortion is expressed in percent.

When differential gain errors are present, color saturation is not correctly reproduced in the picture.(color saturation is determined by the relationship between the amplitudes of chrominance and luminance portions of the signal, is not correctly transferred through the system).

Luminance Non-Linearity

Luminance non-linearity, or differential luminance, is present if luminance gain is affected by luminance levels. In other words, there is non-linear relationship between the input and output signals in the luminance channel. The amount of luminance non-linearity is expressed as percentage of the largest step to the smallest step as compared

to the largest step.

People are not particularly sensitive to luminance non- linearity in black and white pictures. If large amount of distortion is present, however one might notice loss of details in shadows and highlights. These effects correspond to crushing or clipping of black and white.

In color pictures, however, luminance non-linearity is often more noticeable. This is because color saturation, to which the eye is more sensitive, is affected.

Chrominance Non-Linear Phase

Chrominance non-linear phase distortion is present if the signal's chrominance phase is affected by chrominance amplitude. These errors are a result of the system's inability to uniformly process all amplitudes of high frequency chrominance information. Chrominance non-linear phase distortion is expressed in degrees of subcarrier phase.

Like differential phase, the effects of chrominance non- linear phase are averaged out in delay line PAL decoders. Hue shifts therefore cannot be detected in the picture.

Chrominance Non-Linear Gain

Chrominance non-linear gain distortion is present if the signal's chrominance gain is affected by chrominance amplitude. These errors are a result of the system's inability to uniformly process all amplitudes of high frequency chrominance information. Chrominance non-linear gain distortion is expressed as a percentage.

Chrominance non-linear gain is often seen as attenuation of relatively high amplitude chrominance signals. It will appear in the picture as incorrect color saturation.

Chrominance to Luminance Intermodulation

Chrominance to luminance intermodulation also known as cross talk or cross modulation, is present when luminance amplitude is affected by superimposed chrominance signal.

When intermodulation distortion is present, color saturation will not be accurately represented in the affected areas of the picture.

2.1.5 Noise Measurement

The amount of noise relative to the signal amplitude is given in terms of the signal-to-noise ratio. A further distinction is whether it is weighted or un-weighted s/n. In case of weighted signal-to-noise ratio the noise to be measured is passed through a weighting filter whose characteristics duplicates eye response to noise(eye is less sensitive to high frequency components than low frequency components in noise).

Noisy picture often appear as grainy or snowy, and sparkles of color may be noticeable. Extremely noisy (less than 30 dB) signals may be difficult for the equipment to synchronise to, and the picture may suffer from blurriness and a general lack of resolution.

2.2 Video Measuring Instrument

Universal television signal analyser 2924 is an all purpose video test waveform measuring instrument[3]. It is highly software oriented and measures, analyzes and displays all the significant parameters of specified composite baseband video test signals which are used by all the major television systems. It can be operated locally from the front panel or in remote mode and provide control information as required by the modern transmission networks and automatic testing systems. The block diagram of the measuring instrument-2924 is given in Fig. 2.4

The instrument comprises a standard mainframe with power supply unit to which are added the user's selected measurement options. In this way each instrument is built to match the user's requirements. when fitted with all the available options 2924 is capable of measuring over 40 parameters. these measurements can be carried out on Full Line and Insertion Test signals.

Any one of the ten inputs can be selected, or by using a separate external video multiplexing unit these can be expanded up to 64 video inputs. Any or all of these

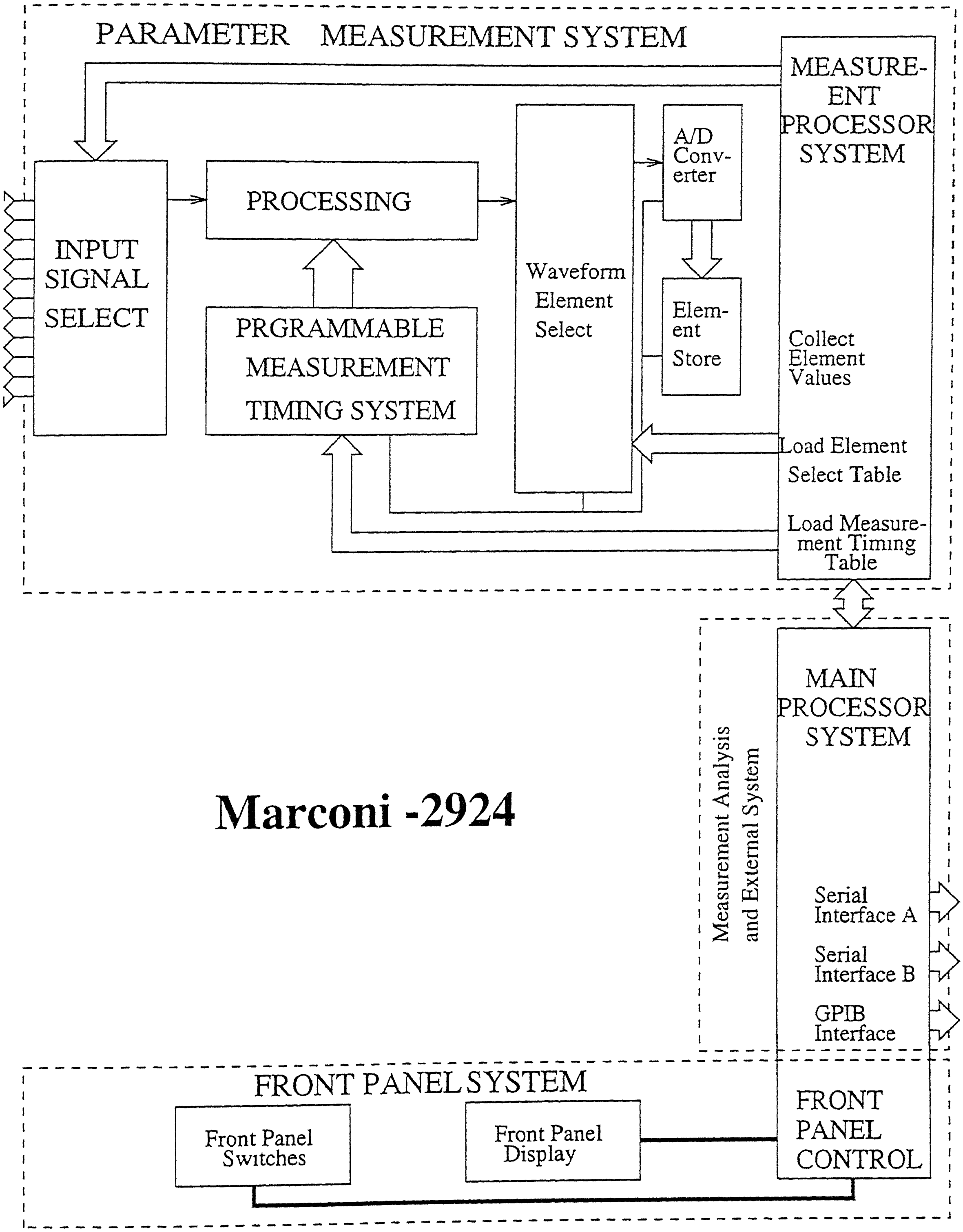

Figure 2.4: System Block Diagram - 2924

can be scanned and monitored in a user defined sequence. Different test waveforms or identical waveforms on different lines can be applied to the video inputs.

All parameters, on up to ten video inputs can be compared with 3 unique limit pairs. The limits are Accept Fail,Caution Fail, Urgent Fail. Limit values can be displayed on request and the factory set values can be modified by the user from the front panel.

Connecters on the rear panel enable 2924 to be operated with up to three external interfaces. These are GPIB communication interface and two RS 232 serial interfaces. The GPIB (IEEE-488) interface has normal talker/listener functions and can also drive a GPIB printer. One RS 232 interface provides the external control of 2924 and general communication to a local or remote visual display unit (VDU) or computer.

The second interface is dedicated to data input from another remote 2924 to access data for the remote relative measurement mode. Each interface can also be used to drive a printer.

In short the three main features of 2924 are:

1. **Three External Interfaces**
2. **Logging Facility**
3. **Remote Relative Measurement**

2.2.1 Interfaces

It has got three communication ports configured as data terminal equipment (DTE). The block diagram of external interface is given the Fig. 2.5

a. GPIB

b. Serial A (RS 232): —For remote control of 2924 by a VDU, computer or a remote 2924.
—To drive a printer.
—To provide a duplicated display.

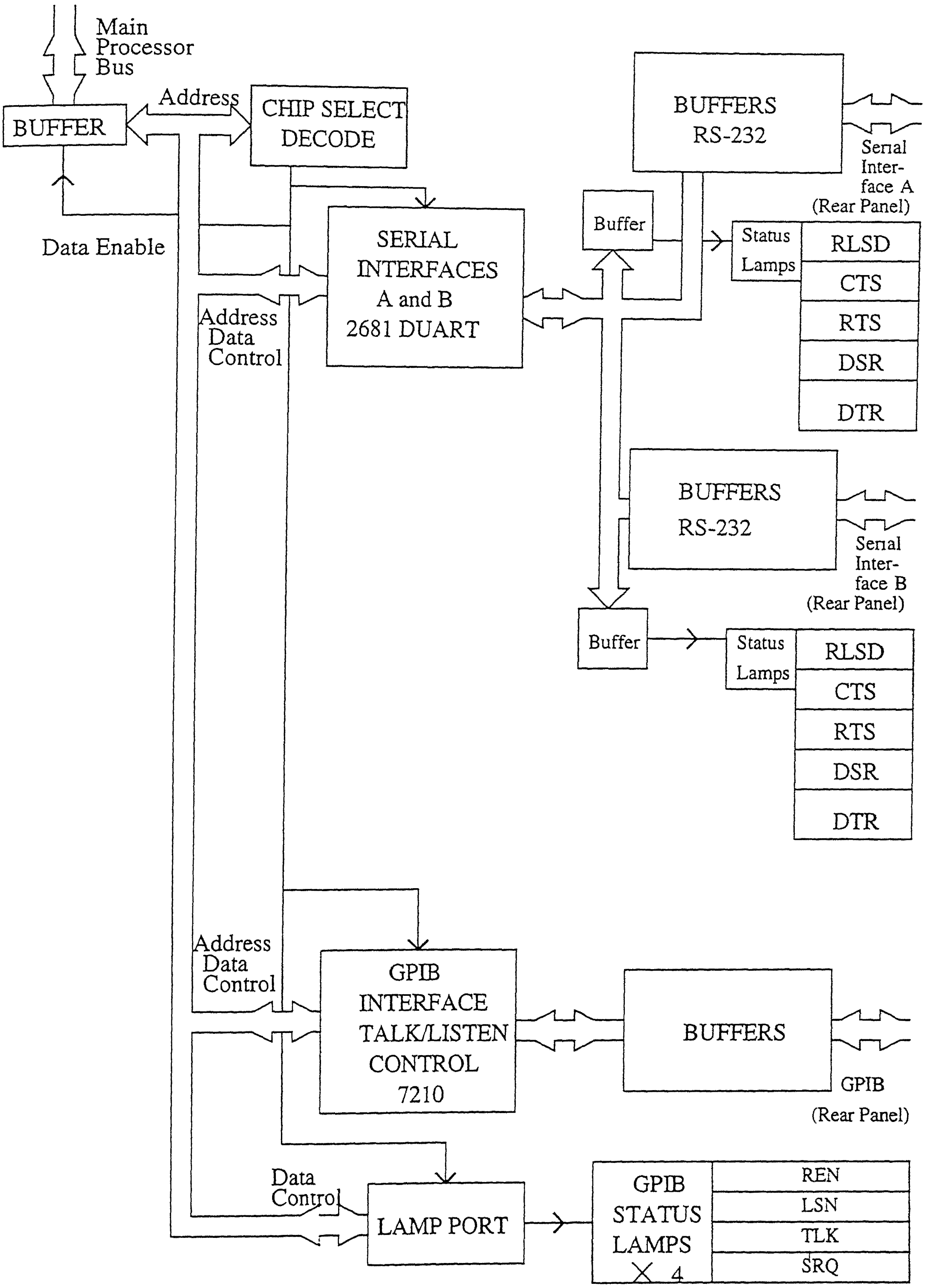

Figure 2.5: External Interface - Block Diagram

c. Serial B (RS 232): —For remote communication with a second 2924 (that sends measuring data).

—To drive a printer.

At any one time only one interface maybe assigned to a particular function and can serve a single function at a time.

The characterstics of the serial interface A and B are given below.

Character code	- ASCII
Transmission type	- Full duplex.
Hardware Definition	- RS 232D, 2924 is always a DTE therefore a MODEM or a NULL modem lead must be used.
Synchronisation	- Asynchronous only.
Char length	- 7 bits.
Parity	- Odd, even, 1, 0, none.
Stop bits	- 1, 1.5, 2.
Baud rate	- Selectable (110 to 9600).
Flow control	- Remote front panel: Software using (ON/OFF) characters. - Serial controller: Hardware using (Modem control lines) and/or software using (XON/OFF characters) or none.
Protocol/handshaking	- Remote front panel: none. - Serial controller : simple ACK/NAK + error checksum, or none.

2.2.2 Logging

—Comprehensive data logging function to a printer or a VDU (with user's programmable intervals) can be implemented.

—Allows selected information to be stored and held ready for access when requested. The logged data can be further selected for printing.

—It has also got auto print on log facility.

2.2.3 Remote Relative Measurements

Connections for the remote relative measurements are shown in Fig 2.6

—This mode enable the measurement results of a remote 2924 to be compared with the measurement results of a second controlling 2924.

—The instrument sends data (query messages) to remote 2924 and remote measurement information is returned automatically.

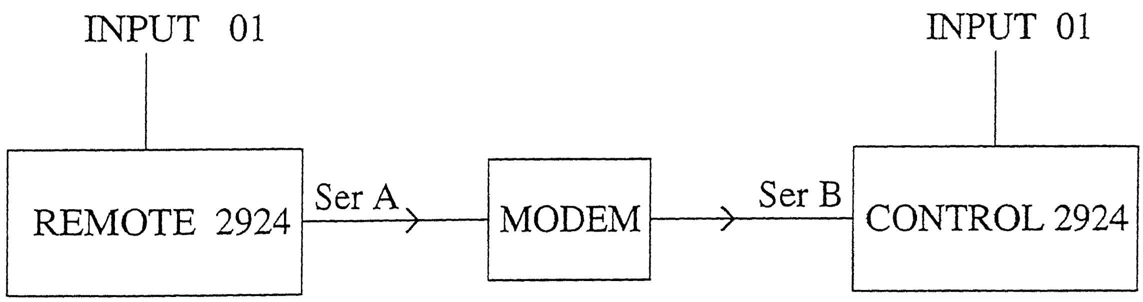

Figure 2.6: Connections for Remote Relative Measurements

2.2.4 Remote Operation

The interfaces are configured by making appropriate selections on the remote control configuration pages. During remote operation all front panel controls except Power ON/OFF and LOCAL are disabled to guard against manual intervention. Pressing the LOCAL key restores manual control under under these circumstances. However

if the controller sends a local lock out command, the LOCAL key is disabled and to restore local operation a further command (GO TO LOCAL) is necessary. A front panel display message indicates when the instrument is under remote control. Most 2924 functions can be remotely controlled.

Chapter 3

Remote Monitoring Setup

The objective of this project is to get the measurement results of the demodulated video of the transmitter at a remote location, that is a Doordarshan Kendra or a Central Monitoring Base, analyze the result and give the necessary feedback to take the corrective action.

To completely achieve the above objective what is required to be done is:

1. Feed the demodulated Video (coupled transmitter output and demodulated through standard demodulator) to the automatic video measuring instrument.

2. Couple the video measuring instrument and PC(transmitter end) so that the measurement results can be transferred to PC(transmitter end).

3. A serial communication channel (i.e. through the RS-232 port) is required to be established between the PC's at transmitter end and Studios/Central Monitoring base end. The PC at the transmitter end is required to be connected to ordinary telephone lines of the PSTN(i.e., public switched telephone network) through Modem and similarly at the remote end (Studios/Central Monitoring Base).

4. The received measurement results are required to be processed and analyzed at the remote end PC

5. The corrective steps/instructions based on the analyses of the received data are required to be sent back to the transmitter end for followup.

6. Successive measured results of individual parameters are required to be displayed in the graphical form,so that we can have proper monitoring of different video

parameters with respect to time.

7. Results are also required in a form where the parameter values are specified simply as ok or not ok.

3.1 Actual Setup

As mentioned earlier, in Doordarshan, the Universal television signal analyzer 2924 is widely used for taking video measurements. This instrument's basic capabilities are described briefly in chapter 2 to show its suitability to be used as a video measuring instrument project . Due to non-availability of 2924 or any other automatic video measuring instrument, actual readings taken (Delhi-Jalandhar Microwave link, Jalandhar transmitter etc.) by the 2924 instrument is stored in a file Meas1 at the local end (transmitter) PC. As the telephone lines and modems were not available, a simple communication channel has been established between the serial ports of the two PC's A 7-pin cable is used to connect serial ports of two PC's.

Then a program has been written, using C-ASYNCH Manager software, to transfer the measurement's results' file Meas1 from the local end (transmitter) PC through the cable to the remote end(studios/central monitoring base) PC, which is polling (program was written using C-Asynch Manager software) the serial port for receiving the file.

On receiving the data file (program written using C-Asynch Manager software), the remote end PC processes the file (program written in Turbo-C) and the necessary instructions based on the analysis of the received measurement data is sent back(again, program written using C-Asynch Manager), as Meas2 file, to the local(transmitter end) PC for the required followup.

The remote end PC responds in OK/not OK format depending upon whether the particular parameter is within the specified limits or not. It also stores the previous measurement results of different parameters in different files and outputs the results of past readings of individual parameters in a graphical format for easy and proper monitoring.

3.2 Processing Steps

In this section the instructions to be sent to the local end after analysing the received data are given. The brief description about the video parameters has already been discussed. Here we include an example of processing which is general in nature. A more detailed and specific processing, to pin-point the fault to a smaller region, will be required to be substituted depending on the type of the transmitter used. For that a thorough knowledge of the circuitry of that particular transmitter will be required.

3.2.1 L F Error

i. If LF error less than 1 percent. then it is OK.

ii. If LF error is between 1 and 2 percent then caution fail i.e. keep the parameter under observation.

iii. If LF error more than 2 percent then

b. Check the earth connections of all the equipment and equipment racks.

c. Check the earthing of the video cable between the microwave rack and the transmitter video input rack.

d. Check the earth resistance of the earth pits.

3.2.2 Burst Amplitude(BA)

i. If BA less than 3 percent, then it is OK.

ii. If it is more than 3 percent, then Control BA through the Stab burst control. If it is more than 10 percent, then

a. Check the output of the microwave link. If the output is not proper replace the video amplifier unit. otherwise communicate with the studio through hotline and try to locate where the fault lies.

b. Check the input of the transmitter.

c. Check the frequency response of the video amplifier of the transmitter otherwise,

d. Check the frequency response of the power stages of transmitter using the

sideband analyser and if the transmitter requires tuning then get the needful done.

3.2.3 Chrominance-to-Luminance(C/L) Gain

If less than 10 percent then OK. otherwise,

a. Check C/L gain at the output of microwave link output.

b. Check C/L gain at the output of video rack of the transmitter.

c. Check the frequency response of the video amplifier in the transmitter.

3.2.4 Chrominance-to-Luminance(C/L) Delay

If less than 15 ns then OK. otherwise,

a. Check C/L delay at the output of microwave link output.

b. Check C/L delay at the output of video rack of the transmitter

c. Check the frequency response of the video amplifier in the transmitter.

d. Check the delay of the baseband filter at the input of the video amplifier of the transmitter.

3.2.5 Luminance Non-Linearity

If it is less than 10 percent then it is OK. otherwise,

a. Check luminance non-linearity at the output of microwave link output.

b. Check luminance non-linearity at the output of video rack of the transmitter.

c. Check for the linearity of the video processor unit of the transmitter over whole of 5 MHz luminance range.

3.2.6 Differential Gain

i. If less than 6 percent then OK.

ii. If between 6 and 10 percent then caution fail, i.e. keep the parameter under observation

iii. If more than 10 percent then

a. Check differential gain at the output of microwave link output.

b. Check differential gain at the output of video rack of the transmitter.

c. Check for the chroma gain at different pedestal i.e. check for the linear response of the chroma amplifier.

3.2.7 Differential Phase(DP)

i. If less than 6 percent then OK.

ii. If between 6 and 15 percent then caution fail.

iii. If more than 10 percent then check the group delay of the baseband filter at the input of the transmitter.

3.2.8 Chrominance Linearity

If less than 6 percent then OK. otherwise,

a. Check chrominance linearity at microwave link output

b. Check chrominance linearity at the output of video rack of the transmitter.

c. Check the linearity of the chrominance amplifier in the video processor of the transmitter.

3.2.9 Chrominance Phase

Not that important a parameter for PAL-D type of decoders. If it is less than 15 percent then it is OK.

3.2.10 Chrominance to Luminance Intermodulation

If it is less than 5 percent then it is OK. otherwise,

Check the non-linearity in amplifier stages of composite video path in the video processor unit of the transmitter.

3.2.11 Multiburst(frequency response)

i. If it is less than 10 percent then it is OK.

ii. If it is between 10 and 15 percent then caution fail i.e., keep the parameter under observation.

iii. If it is greater than 15 percent then go for overall alignment of different power stages of the transmitter, using sideband analyser or spectrum analyser.

3.3 Processing Results

Processing results on some of the received measurement data, file meas1,for the **ideal** (i.e., excellent rating), **normal**(i.e., average rating) and **worst**(i.e., poor rating) cases have been given in this section.

Case 1

For the **ideal case**, the received measurement data(file meas1) is of the form shown below.

File meas1

diff. phase:3

diff. gain:2

chr loss:5

s/n wtd:55

s/n unwtd:50

l f error:0.5

burst ampl:0.5

c/l gain:4

c/l delay:9

lum non-lin:2

chr lin:0.7

chr phase:1.6

c/l x-talk:0.7

multiburst:2

The **analysis result**,file meas2, on the above received data which, is to be sent back to the local end is of the form shown below.

File meas2

Parameter=diff. phase:	Value=3.000000	OK.
Parameter=diff. gain:	Value=2.000000	OK.
Parameter=chr loss	Value=5.000000	OK.
Parameter=s/n wtd:	Value=55.000000	OK.
Parameter=s/n unwtd:	Value=50.000000	OK
Parameter=l f error:	Value=0.500000	OK.
Parameter=burst ampl.	Value=0.500000	OK.
Parameter=c/l gain:	Value=4.000000	OK.
Parameter=c/l delay·	Value=9.000000	OK.
Parameter=lum non-lin:	Value=2.000000	OK.
Parameter=chr lin:	Value=0.700000	OK.
Parameter=chr phase:	Value=1.600000	OK.
Parameter=c/l x-talk:	Value=0.700000	OK.
Parameter=multiburst:	Value=2.000000	OK.

Case 2

For the **normal case, the** received measurement data(file meas1) is of the form shown below.

File meas1

diff. phase:7

diff. gain:8

chr loss:7

s/n wtd:30

s/n unwtd:25

l f error:6.5

burst ampl:10.5

c/l gain:14

c/l delay:29

lum non-lin:12

chr lin:6.7

chr phase:7.6

c/l x-talk:5.7

multiburst:7

The **analysis result**,file meas2, on the above received data which, is to be sent back to the local end is of the form shown below.

File meas2

Parameter=diff. phase:	Value=7.000000	NOT OK.

Caution fail, i.e., keep the diff. phase parameter under observation.

Parameter=diff. gain:	Value=8.000000	NOT OK.

Caution fail, i.e.. keep the diff. gain parameter under observation

Parameter=chr loss:	Value=7.000000	NOT OK.

correct chroma.

Parameter=s/n wtd:	Value=30.000000	NOT OK.

correct s/n.

Parameter=s/n unwtd:	Value=25.000000	NOT OK.

correct s/n.

Parameter=l f error:	Value=6.500000	NOT OK.

1. Check Hum suppressor.
2. Check the earth connections of all the equipment and equipment racks.
3. Check the earthing of the video cable between the microwave rack and the transmitter video input rack.
4. Check the earth resistance of the earth pits.

Parameter=burst ampl: Value=10.500000 NOT OK.

1. Check the output of the microwave link. If the output is not proper replace the video amplifier otherwise, communicate with the studio through hotline and try to locate where the fault lies.

2. Check the input of the transmitter.

3. Check the frequency response of the video amplifier of the transmitter otherwise,

4. Check the frequency response of the power stages of transmitter using the sideband analyser and if the transmitter requires tuning then get the needful done.

Parameter=c/l gain: Value=14.000000 NOT OK.

1. check C/L gain at the output of microwave link output.

2. check C/L gain at the output of video rack of the transmitter.

3. Check the frequency response of the video amplifier in the transmitter.

Parameter=c/l delay: Value=29.000000 NOT OK.

1. check C/L delay at the output of microwave link output.

2. check C/L delay at the output of video rack of the transmitter.

3. Check the frequency response of the video amplifier in the transmitter.

4. Check the delay of the baseband filter at the input of the video amplifier of the transmitter.

Parameter=lum non-lin: Value=12.000000 NOT OK.

1. check luminance non-linearity at the output of microwave link output.

2. check luminance non-linearity at the output of video rack of the transmitter.

3. Check for the linearity of the video processor unit of the transmitter over whole of 5 MHz luminance range.

Parameter=chr lin: Value=6.700000 NOT OK.

1. check chrominance linearity at microwave link output .

2. Check chrominance linearity at the output of video rack of the transmitter.
3. Check the linearity of the chrominance amplifier in the video processor of the transmitter.

Parameter=chr phase:	Value=7.600000	OK.
Parameter=c/l x-talk:	Value=5.700000	NOT OK.

1.Check the non-linearity in amplifier stages of composite video path in the video processor unit of the transmitter.

Parameter=multiburst:	Value=7.000000	OK.

Case 3

For the **worst case, the** received measurement data(file meas1) is of the form shown below.

File meas1

diff. phase:19

diff. gain:16

chr loss:18

s/n wtd:28

s/n unwtd:25

l f error:11

burst ampl:16

c/l gain:18

c/l delay:70

lum non-lin.18

chr lin:18

chr phase:17

c/l x-talk:19

multiburst:25

The **analysis result**, file meas2, on the above received data which, is to be sent

back to the local end is of the form shown below.

File meas2

Parameter=diff. phase: Value=19.000000 NOT OK.

Check the group delay of the baseband filter at the input of the transmitter.

Parameter=diff. gain: Value=16.000 NOT OK.

1. Check differential gain at the output of microwave link output.
2. check differential gain at the output of video rack of the transmitter.
3. Check for the chroma gain at different pedestal i.e check for the linear response of the chroma amplifier.

Parameter=chr loss Value=18.000 NOT OK.

Correct chroma.

Parameter=s/n wtd Value=28.000 NOT OK.

Correct s/n.

Parameter=s/n unwtd: Value=25.000 NOT OK.

Correct s/n.

Parameter=l f error: Value=11.000 NOT OK.

1. Check Hum suppressor.
2. Check the earth connections of all the equipment and equipment racks.
3. Check the earthing of the video cable between the microwave rack and the transmitter video input rack.
4. Check the earth resistance of the earth pits.

Parameter=burst ampl Value=16.000 NOT OK.

1. Check the output of the microwave link.

If the output is not proper replace the video amplifier unit.

Otherwise, communicate with the studios and check

where fault lies.

2. Check the input of the transmitter.
3. Check the frequency response of the video amplifier of the transmitter otherwise,

4. Check the frequency response of the power stages of transmitter using the sideband analyser and if the transmitter requires tuning then get the needful done.

Parameter=c/l gain Value=18.000 NOT OK.

1. check C/L gain at the output of microwave link output.
2. check C/L gain at the output of video rack of the transmitter.
3. Check the frequency response of the video amplifier in the transmitter.

Parameter=c/l delay Value=70.000 NOT OK.

1. check C/L delay at the output of microwave link output
2. check C/L delay at the output of video rack of the transmitter.
3. Check the frequency response of the video amplifier in the transmitter.
4. Check the delay of the baseband filter at the input of the video amplifier of the transmitter.

Parameter=lum non-lin Value=18.000 NOT OK.

1. check luminance non-linearity at the output of microwave link output.
2. check luminance non-linearity at the output of video rack of the transmitter.
3. Check for the linearity of the video processor unit of the transmitter over whole of the 5 MHz luminance range.

Parameter=chr lin Value=18.000 NOT OK.

1. check chrominance linearity at microwave link output
2. check chrominance linearity at the output of video rack of the transmitter.
3. Check the linearity of the chrominance amplifier in the video processor of the transmitter.

Parameter=chr phase Value=17.000 NOT OK

Not that important a parameter for PAL-D type of decoders.

Parameter=c/l x-talk: Value=19 000 NOT OK.

1.Check the non-linearity in amplifier stages of composite video path in the video processor unit of the transmitter.

Parameter=multiburst Value=25.000 NOT OK.

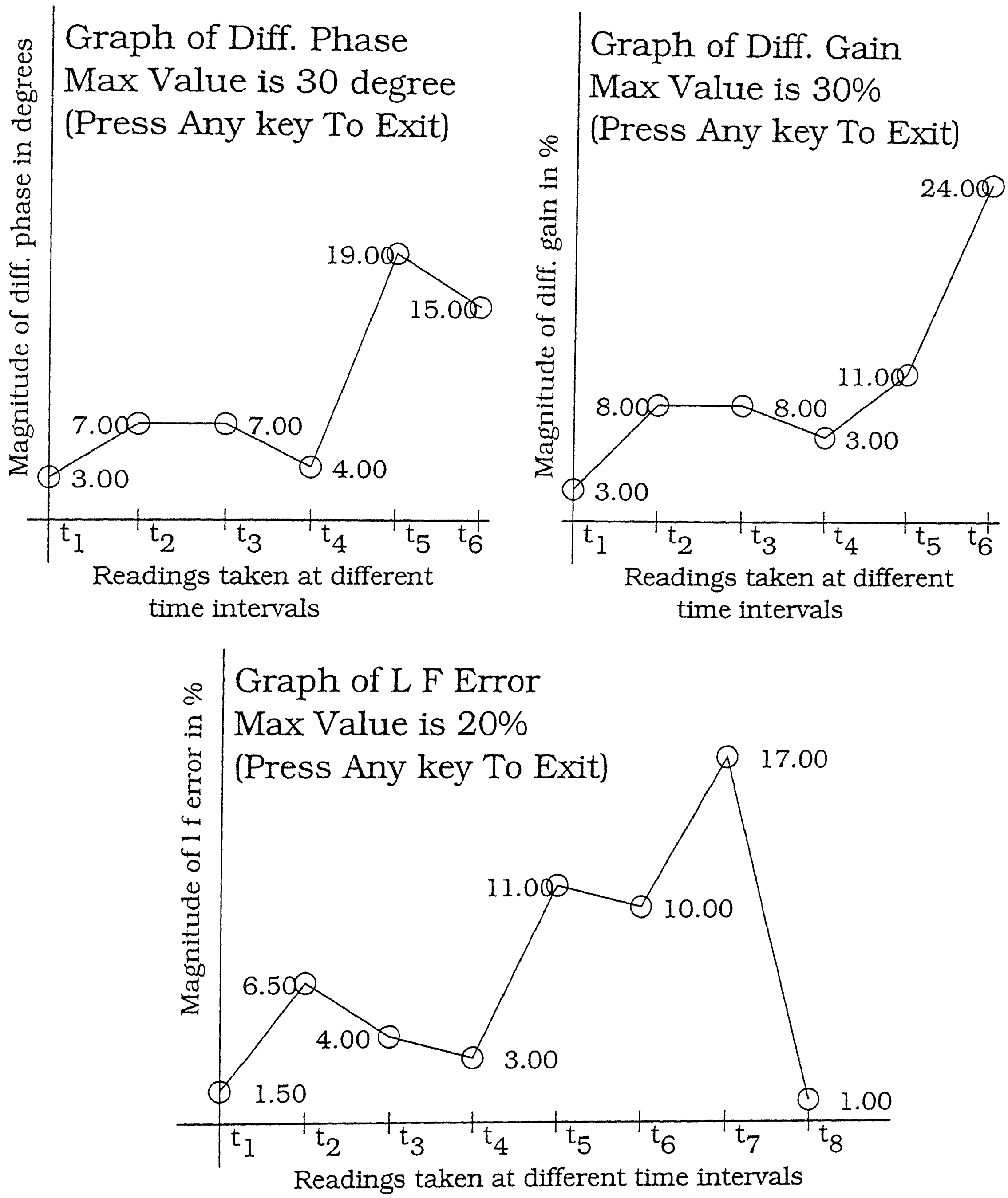

Figure 3.1: Display of the variations of DP, DG, LF ERROR for some past measurement values

Go for overall alignment of different power stages of the transmitter, using sideband analyser or spectrum analyser.

Graphs, of past 4-5 readings, for differential phase, differential gain, and lf error are shown in Fig. 3.1

Chapter 4

Conclusions

This project has been undertaken, basically, to remote monitor the quality of the video signal broadcast by a TV broadcasting station, thereby enabling the senior officials to keep a watch over the working and the health of the transmitter. Due to the non-availability of Modems and the Video measurement instrument 2924, software has been written and connections made to realize a basic model of monitoring link. The above setup has been made and tested.

The two ends, transmitter end(i.e., local) and the studios/central monitoring base end(i.e.,remote), are simulated by PC's and a simple RS-232 serial port interconnections through cable has been taken as the channel, instead of the actual Modems and telephone line channel.

The measurement data is received at the remote PC and the received data is processed and the instructions to be implemented for corrective action are stored in a file Meas2 and sent back to the local PC. Also the past measurement results of different parameters are stored in different files and the past measurement readings can be plotted as and when required by the person monitoring the results, thereby enabling him to know the variation of any particular parameter with time, helping him in keeping track of the health of the transmitter.

The analysis result was also presented in a ok-not ok format to enable the person, remotely monitoring the transmitter, to have a quick check on the status of transmitter health.

4.1 Further Work

Firstly this remote monitoring arrangement can be tested over actual telephone lines using Modems. And the local end PC can be connected to the video measurement assembly 2924.

Secondly a comprehensive monitoring network can be established, taking in the data from two or three different transmitter locations. Then the individual transmitter data can be processed and the followup instructions sent back and also present the data at the central monitoring base in quick to assimilate fashion. Also the communication between the two ends can be made interrupt driven i.e. the two PC's are free and the communication link is established, only, whenever required.

The remote relative measurement capability of 2924, as described in chapter 2, can be used to compare the readings of different sources to some standards and multiple network can be established i.e. one 2924 can be made master and other sources(2924) at that location only, can be made slaves and the communication channels can be made between the master 2924 and the remote location(i.e. major studios/centralized monitoring stations).

A more detailed processing depending on the type of the transitter can be made thereby improving the broadcast quality and reducing the hours of breakdown.

Besides the above(i.e., performance parameters) some other parameters(like,voltage stabilization, temperature etc.) are important for the proper working of the transmitting station. Some arrangement to sense the above parameters and convert the results to a digital signal can be made. And this signal can also be multiplexed with the above measurement results to provide a more comprehensive remote monitoring of the transmitting station.

Last but not the least all the above can be put to practical use in the Doordarshan network.

Appendix A

C-Asynch Manager

The programs for this project are written in Turbo-C and for dealing with the outside world i.e., the asynchronous communication , a special software, C-Asynch Manager version 4.0 (custom made for this purpose)[4], has been used.

C-Asynch Manager has a comprehensive set of functions that allows one to build asynchronous communications into ones C and C++ programs. Using these functions one can write software to drive almost any serial device or communicate with other computers. It is designed specifically to be used with IBM compatible family of PCs', including the ISA, EISA and micro-channel architecture systems. These functions provide:

1. Support for upto eight communications ports simultaneously;

2. Interrupt driven, buffered serial communication support;

3. Broad baud rate settings. 19,200 baud can be used for both transmitting and receiving even on standard machines, and baud rate upto 112,000 can be specified if your hardware can support these speeds;

4. Support for the 16550A UART buffered FIFOs;

5. XON/XOFF software flow control protocol;

6. File transferring capability using ASCII, XMODEM, YMODEM, and KERMIT protocols;

7. Support for the Borland and Microsoft C and C++ compilers.

This software contains the functions in three levels Level 1, Level 2, Level 3. The

LEVEL ZERO functions provide the most basic asynchronous support. These functions initialize the communication ports, provide interrupt service support, and transfer data between circular queues and communication ports. All level zero functions are written in assembly language and drive the UART and the Programmable Interrupt Controller(PIC) directly.

The LEVEL ONE functions constitute a C application program interface(API) to level zero eliminating the need to use assembly language. LEVEL ONE functions were used by myself in writing the programs for this project.

A.1 Modem Control

The modem control functions configure and operate standard modems. The modem control functions, like file transfer functions, are state-driven and thus allow an application program to answer a call on one port while dialling a number on another. They support Hayes compatible modems and the advanced featured modems that are now common. This facility of modem control can be utilised when extending the communication channel to the telephone lines.

Appendix B

RS-232 Serial Interface Port

B.1 Standards

RS-232 is by far the most popular serial interface standard[5]. First introduced in 1962, it was intended to describe the interface between the computer and a modem. In RS-232 jargon, the terminal is referred as DTE(data terminal equipment) and the modem as DCE (data communications equipment). The specification limits the baud rate to 19,200 with 50-ft cable. In practice, much longer cables can be accommodated but at lower data rates. RS-232 is a voltage standard with typical logic levels of -12 volts for logic 1 and +12 volts for logic 0 In addition to the electrical characteristics, the standard also defines 25/9-pin connector with signals defined for the pins. Three wires are required for data transmission: Ground-Ground, Transmit- Receive and Receive-Transmit. Seven wires are required if we want to use handshaking. Connections are given in table B.1.

9-pin	25-pin		25-pin	9-pin
pin 5 (Gnd-Gnd)	pin 7	$\longleftrightarrow$	pin 7	pin 5
pin 3 (Tr-Rec)	pin 2	$\longleftrightarrow$	pin 3	pin 2
pin 7 (RTS-CTS)	pin 4	$\longleftrightarrow$	pin 5	pin 8
pin 6 (DSR-DTR)	pin 6	$\longleftrightarrow$	pin 20	pin 4
pin 2 (Rec-Tr)	pin 3	$\longleftrightarrow$	pin 2	pin 3
pin 8 (CTS-RTS)	pin 5	$\longleftrightarrow$	pin 4	pin 7
pin 4 (DTR-DSR)	pin 20	$\longleftrightarrow$	pin 6	pin 6

Table B.1: RS-232 interface connection

References

[1] Geoffrey H. Hutson, Peter J. Shepherd and W.S. James, " *Colour Television*",McGraw-Hill Book Company, second edition, pp. 287-371.

[2] "*Television Measurements, PAL Systems*", Tektronix.

[3] "*Universal Signal Television Analyser, 2924* ", Marconi Instruments.

[4] "*C Async manager, Version 4.0(User Reference Manual)*", Blaise Computing inc.

[5] J.Uffenbeck,"*Family of 8088/8086* ", Prentice-Hall, second edition, pp. 475-479.